Report of the Scientific Review Committee with respect to submissions received concerning proposed 1998 revisions to NAC Protocols for Introduction and Transfer of Salmonids

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Dr. T. Beacham, Chair, Review Committee

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Preamble

Amendments to the Protocols for the Introduction and Transfer of Salmonids for use within the North American Commission Area (NAC(94)14) were approved by the North American Commission (NAC) of the North Atlantic Salmon Conservation Organisation (NASCO) at its 11th annual meeting in June 1994. The NAC(94)14 amendments deal with specific changes made to Part I (Summary Protocols by Zone) and Part III (Protocols for maintenance of Genetic Diversity in Atlantic Salmon) of the original Protocols which were first adopted by the NAC at its 9th annual meeting in June 1992 (NAC(92)24). Because of the manner in which the documents were published by NASCO, both the NAC(92)24 and NAC(94)14 documents must be read together in order to understand the Protocols.

The fundamental objectives of the Protocols (proposed 1998 Revision) are to minimize the risks of:

(a) introduction and spread of infectious disease agents (fish health);
(b) reduction in genetic diversity and prevention of the introduction of non-adaptive genes to wild Atlantic salmon populations (genetics); and
(c) intra- and inter-specific ecological interactions of introductions and transfers on Atlantic salmon stocks.

The North American Commission (USA and Canada members of NASCO) has a Scientific Working Group, composed of American and Canadian government scientific staff, to review the protocols on a regular basis in light of salmonid introduction and transfer activity within the NAC and to propose changes as appropriate. The Scientific Working Group recently proposed the 1998 Revisions to the NAC Protocols for the Introduction and Transfer of Salmonids (NAC(92)24 and NAC(94)14). The Department of Fisheries and Oceans, as the NAC representative, circulated the 1998 Revision document to Canadian stakeholders for comment and is presently reviewing their comments.

As part of that review, a Scientific Review Committee was established by DFO to address the approximately 30 submissions commenting on the proposed 1998 revisions. The Committee, composed of science specialists, had the mandate to review the scientific issues raised within the stakeholder letters and comments. Committee members were instructed to remain scientifically objective in their review of the questions and concerns raised by the stakeholders. The following report is respectfully submitted by the Scientific Review Committee.

The members of the Scientific Review Committee were: T. Beacham (Pacific Region) (Chair), J. Ritter (Maritimes Region), T. Sephton (Maritimes Region), G. Olivier (Gulf Fisheries Management Region), and M. O'Connell (Newfoundland Region).

Comments on General Concerns expressed by numerous stakeholders.

1) The 1998 revisions pose a zero risk management scenario.

The 1998 Revision of the NAC Protocols state clearly that they are intended to minimize the risks of 1) introduction and spread of infectious disease agents (fish health); 2) reduction in genetic diversity and prevention of the introduction of non-adaptive genes to wild Atlantic salmon populations (genetics); and 3) intra- and inter-specific ecological interactions of introductions and transfers on Atlantic salmon stocks. There is a perception that their application by DFO, as a NAC Contracting Party, has sometimes been inconsistent, having either not gone quite far enough or too far depending on the stakeholder's perspective. This, unfortunately, has led to a polarization of two principal stakeholders associated with the NAC Protocols and NASCO, the conservationist and aquaculture development groups.

DFO plays a dual role within the Canadian Government as both the lead federal agency for sustainable aquaculture development in Canada and the lead agency for the conservation of fish and fish habitat in both the marine and freshwater environments. In all cases, the approach has been to minimize the risks through a risk management process used by the local Introduction and Transfer Committees.

Conclusion: The lack of a formal risk analysis process as part of either the NAC Protocols or Regional DFO Introduction and Transfer policy, precludes a standardized transparent process from occurring and being readily understood by all stakeholders. The Committee recognizes the need for a standardized risk analysis process within the NAC Protocols to address concerns raised by stakeholders.

2) Aquaculture development is the only reason for the 1998 Revision.

The Scientific Working Group revises the NAC Protocols on a regular basis. The 1998 revisions incorporate and are consistent with the most recent information stemming from the NASCO Bath Conference (April 1997) and the Maritimes Region Regional Assessment Process Meeting Report (1998), both of which examined the interaction of wild and cultured salmon. This, unfortunately, has been misconstrued as an attempt by NAC to manage the salmon aquaculture industry in Atlantic Canada and a further polarization of the stakeholders. Aquaculture is but one of many issues addressed by the NAC Protocols and NASCO in its efforts to conserve and protect wild Atlantic salmon.

3) The Precautionary Approach is undefined in the 1998 Revisions.

Although a Precautionary Approach is referred to in protocol 5.5, there is no clear definition of a Precautionary Approach included in the protocols. As the definition of a Precautionary Approach may differ among organizations, it is recommended that a clear definition of the Precautionary Approach as applied by NAC be appended to the protocols.

4) Not all of the issues identified by stakeholders were addressed by the Committee.

The terms of reference for the Committee clearly stated that it was to only deal with those scientific issues raised by the stakeholders' letters and comments. The

Committee did not have a mandate to conduct a critical review and comment on the NAC 1998 Revisions nor was it to address management issues raised by stakeholders. However, there is one issue raised by stakeholders, which pertains directly to the protocols, that should be given some consideration. This concerns the protocol dealing with the eradication or control of introduced species (2.2.1(l)). The protocol as stated is vague in terms of its application. Criteria for determining the level of risk need to be outlined as well as an acceptable time frame for eradication.

Comments on "Specific Concerns" expressed by stakeholders

Genetics

Issue: Concerning protocol 2.2.1 (a) "Gametes and reproductively viable strains of Atlantic salmon of European origin, including Icelandic origin, are not to be released or used in Aquaculture in the North American Commission Area."

Introduction

The possible genetic impact of European or Icelandic domesticated strains of Atlantic salmon on wild populations in North America has been an area of continuing concern. Is there scientific evidence to evaluate possible genetic impacts of interbreeding between escaped domesticated salmon and wild salmon or is the situation as indicated by CAIA (1999), namely "Since the direct experimental evidence necessary to reach a definitive conclusion is lacking, the stance taken by either side can only be based on opinion." The Committee reviewed the scientific evidence under the following five questions with respect to possible genetic interactions.

1) Are wild populations of Atlantic salmon genetically differentiated?

Genetic differentiation occurs as a consequence of the homing behavior of salmonids to their natal stream during spawning migrations. Genetic differentiation among wild Atlantic salmon populations has been observed at neutral genetic loci in surveys of variation at allozyme loci (Davison et al. 1989; Jordan et al. 1992; Sanchez et al. 1996; Bourke et al. 1997), minisatellite loci (Galvin et al. 1995; Galvin et al. 1996), mitochondrial DNA (Tessier et al. 1997), and microsatellite loci (Sanchez et al. 1996; Nielsen et al. 1997; McConnell et al. 1997; Beacham and Dempson 1998). Similar genetic differentiation among populations has also been observed in other salmonid species (Angers et al. 1995; Bernatchez et al. 1998; Wenburg et al. 1998; Small et al. 1998). Neutral genetic differentiation, arising from mutation and genetic drift (stochastic changes in allele frequencies) is therefore common among wild salmonid populations. This differentiation is maintained in the presence of restricted gene flow among populations, and indicates that potential exists for genetic differentiation at loci under natural selection (adaptive loci) to occur.

Conclusion: Wild populations of Atlantic salmon are genetically differentiated.

2) Does adaptive genetic variation exist among salmon populations?

Adaptive genetic differentiation among salmon populations is thought to be important for survival and recruitment under local conditions (Taylor 1991; Verspoor 1997), allowing salmon to exist in a wide variety of freshwater habitats and become sufficiently productive to support fisheries and recover from periods of poor marine survival. Adaptive differentiation is sometimes reflected in phenotypic (expressed) variation in life history, morphology, meristics, size and other measurable traits among populations, although not all phenotypic variation has a genetic basis. Genetic differences in body morphology have been observed among Atlantic salmon populations of the Miramichi River that were correlated with flow characteristics, and therefore likely adaptive (Riddell and Leggett 1981; Riddell et al. 1981). Genetic differences in egg mortality correlated with pH have been observed in Atlantic salmon in a Scottish River (Donaghy and Verspoor 1997). Genetic differences in timing of adult return correlated with river water levels in Norwegian rivers was reported by Hansen and Jonsson (1991). Adaptive population differences have also been observed for parasite resistance and are correlated with the presence or absence of parasites in their native environments (Bakke et al 1990; Bakke and Mackenzie 1993; Rintamakikinnunen and Valtonen 1996). Adaptive variation has been observed in many other salmonids, with a few examples outlined by Wood and Foote (1990) and Bower et al. (1995). Adaptive differentiation also has been detected by molecular biology techniques among salmonid populations at biochemical loci, such as MHC genes which are involved in disease resistance, for which the particular selective agent (e.g. a parasite or pathogen) is not yet known (Miller and Withler 1997, 1998; Kim et al. 1999).

Genetic differentiation between populations is correlated with geographic distance (Bourke et al. 1997), so the greater the geographic distance between local and introduced populations, the greater is the potential for adaptively important genetic differentiation to exist between them. Adaptive genetic differentiation is likely to be greatest when the introduced fish are from a different regional population group that was historically isolated from the local population group. In Atlantic salmon, the populations of North American and Europe form different regional groups (Verspoor 1997). Adaptive differences are also likely to result from the genetic changes incurred during domestication, so European or Icelandic domesticated salmon are likely to be adapted to very different environments than North American wild salmon.

Conclusion: There are important genetically controlled adaptive differences among salmon populations.

3) Are there genetic differences between wild and domesticated Atlantic salmon?

There is the potential for a domesticated strain of Atlantic salmon to become genetically differentiated with respect to the wild populations from which it originated. Selection for characters enhancing economic performance will alter the genome of the domesticated strain relative to that of wild populations. Additional genetic variability may be lost in the domesticated strain because of the use of small numbers of parents or mating of close relatives. The reduced genetic variation of a domesticated strain may result in a reduced number of alleles present at genetic loci (reduced allelic diversity), and a reduced proportion of heterozygous individuals (those that inherit different alleles

from their mother and father at a genetic locus) in the strain. Some studies of allozyme loci have indicated that heterozygosity is reduced in domesticated strains of Atlantic salmon relative to wild populations (Cross and King 1983; Verspoor 1988), whereas other studies found no evidence of reduced heterozygosity in domesticated salmon (Crozier and Moffett 1989; Mjolnerod et al. 1997; Danielsdottir et al. 1997). For microsatellite loci, some studies indicate that domesticated Atlantic salmon were less heterozygous than wild populations (Mjolnerod et al. 1997) or had reduced allelic diversity (Mjolnerod et al. 1997; Norris et al. 1999). Virtually all studies show that domesticated Atlantic salmon are genetically distinct compared with wild populations surveyed (Danielsdottir et al. 1997; Norris et al. 1999). Differentiation is observed in adaptive as well as neutral genetic loci.

Conclusion: Genetic differences have been observed between wild and cultured salmon, with the largest differences expected to be observed between domesticated salmon from Europe or Iceland and wild salmon in North America.

4) Can wild and domesticated salmon interbreed?

Wild and domesticated salmon have the potential to interbreed when domesticated salmon escape from culture cages, perhaps rearing in the marine environment for a period, and then move into rivers during the time of spawning of wild salmon. Are there biological mechanisms that prevent interbreeding, and if not, is there evidence that wild and domesticated salmon interbreed? Available evidence suggests that there are differences in timing of fresh water entry (Jonsson 1997), spawning behaviour (Fleming et al. 1996), and reproductive success (Clifford et al. 1998) between wild and domesticated salmon that will limit the degree of interbreeding between wild and domesticated salmon. However, it is clear that there is interbreeding between wild and escaped domesticated salmon (Crozier 1993; Webb et al. 1993; Clifford et al. 1998) and in some cases the majority of the fry production in a population may been derived from escaped cultured females (Carr et al. 1997; Saegrov et al. 1997).

Conclusion: Wild and escaped domesticated Atlantic salmon can interbreed, and in some cases escaped domesticated salmon can form the majority of fish in the spawning population.

5) If wild and domesticated salmon interbreed, what is the impact?

The central issue of concern regarding impacts of interbreeding between wild and domesticated salmon is whether fitness (contribution to the next generation) of the wild population is reduced as a result of the interbreeding (outbreeding depression). In an earlier review, Hindar et al. (1991) indicated that where genetic effects on performance traits had been documented with respect to interbreeding between wild and domesticated salmonids, they always appear to be negative in comparison with unaffected wild populations. In a comparison of wild, hybrid, and farmed Atlantic salmon, McGinnity et al. (1997) reported that survival of the progeny of farmed salmon to the smolt stage was significantly lower than that of wild salmon, and that of hybrid wild-farmed progeny was intermediate. However, the domesticated and hybrid progeny grew faster than wild progeny and competitively displaced smaller wild salmon downstream. If, as seems likely, the survival of the wild juveniles is reduced as the result of

displacement, and marine survival of domesticated and hybrid fish is low, then reduced recruitment to the next generation will occur. The effects of hybridization on wild populations experiencing a continuous influx of domesticated fish could be significant. As the study of McGinnity et al. (1997) demonstrated, there is the potential for both direct genetic impacts through interbreeding and indirect or ecological impacts even when interbreeding does not occur (the displacement of juvenile wild fish by domesticated fish that may fail to complete the life cycle). Fleming and Einum (1997) reported that farming of Atlantic salmon generated rapid genetic change that altered important fitness-related traits relating to behaviour and growth. Skaala et al. (1996) reported that survival of young juveniles was nearly three times higher in wild brown trout than in hybrids of wild and introduced (and genetically distinct) trout. Reisenbichler and Rubin (1999) reviewed a number of studies on Pacific salmon and concluded that they provide strong evidence that fitness for natural spawning and rearing can be rapidly and substantially reduced by interbreeding between wild salmon and those produced by artificial propagation.

Peterson (1999) suggested that genetic variation for traits directly associated with fitness is lost in wild populations as the result of directional selection in a stable environment, with the result that many loci associated with fitness have become homozygous. He postulated that under these circumstances interbreeding between wild salmon and domesticated salmon, and particularly with a genetically distinct domesticated strain, might provide the wild population with additional genetic variation that would increase its potential for adaptation and fitness. In fact, almost all studies of adaptive genetic variation (variation for traits such as growth rate, disease resistance, homing ability, etc.) in salmonids reveal the existence of genetic variation within, as well as among, wild salmonid populations. There have been no studies documenting a beneficial effect of hybridization between an introduced and a local wild salmonid population.

Conclusion: There is no evidence to indicate that interbreeding between wild and domesticated salmon will be beneficial to the wild population. There is evidence to indicate that there has been a reduction of fitness in wild populations in the short term when wild and domesticated salmonids have interbred.

Overall Conclusion: After review of the available scientific information, the Committee finds no scientific basis to revise the protocol, and thus no change is recommended to protocol 2.2.1 (a).

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Issue: If only North American derived Atlantic salmon broodstocks are to be used in aquaculture in Atlantic Canada, is the origin of the domesticated broodstock a concern?

In North America, genetic differentiation at neutral loci has been observed among Atlantic salmon populations (McConnell et al. 1997). Genetic variation has also been observed in traits directly correlated with fitness, such as juvenile body morphology in Miramichi River Atlantic salmon (Riddell and Leggett 1981; Riddell et al. 1981). Thus populations of Atlantic salmon are genetically differentiated, and adaptation to local environments allows wild salmon to survive in a variety of habitats. This local adaptation is the basis for their productivity and capacity to support fisheries or recover from periods of low marine survival. Disruption of the genome adapted to the local environment (outbreeding depression) and thus reduced fitness is expected when genetically distinct salmon interbreed. This has been demonstrated in interbreeding between wild and domesticated populations in Europe (McGinnity et al. 1997). The level of outbreeding depression is correlated with the genetic distinctiveness between interbreeding populations. Genetic differentiation between populations is correlated with geographic distance (Bourke et al. 1997), so if interbreeding between wild and escaped domesticated salmon occurs, disruption of the adapted genome of the wild population

will be reduced the more genetically similar the domesticated population. Danielsdottir et al. (1997) suggested that populations from a local region should be considered for enhancement and aquaculture if disruption of local adaptation is to be avoided.

Conclusion: In Atlantic Canada, there is no direct evidence to indicate that interbreeding between wild and escaped domesticated salmon has directly led to reduced fitness of wild populations. No surveys have been conducted to evaluate this issue. However, relatively "local" domesticated strains have been used, and this would tend to reduce genetic differences between between wild and domesticated populations. If more geographically distant North American domesticated strains are used in aquaculture and they escape and breed with wild fish, reduced fitness of wild populations would be expected, similar to observations on European populations.

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Ecology

Issue: Is sterilization of cultured rainbow trout necessary to protect the wild Atlantic salmon stocks? (Protocol 2.2.3.1 (a))

On the Pacific coast the anadromous form of rainbow trout, the steelhead, appears to be an ecological equivalent of Atlantic salmon. This Pacific salmonid therefore has the potential for competing with Atlantic salmon. Both species have relatively long fluviatile stages, migrate to sea in the spring at similar sizes, and can spend a year or more at sea. Steelhead make long oceanic migrations in the North

Pacific Ocean, comparable to those of Atlantic salmon in the North Atlantic, and eat comparable prey. Again similar to salmon, steelhead trout may spawn more than once, unlike the congeneric Pacific salmons (Briggs 1953; McAfee 1966).

Locally, rainbow trout are established in one southern New Brunswick stream (i.e., Crooked Creek), some Prince Edward Island streams, one or more small brooks on Cape Breton Island and several streams on Insular Newfoundland. These naturally reproducing populations have been established for many years and are believed to be the product of government stocking programs ongoing for at least a century. Some public water stocking of rainbow trout continues to be carried out in Nova Scotia, but in a more restricted manner than in the past relative to strain of origin and stocking location. Stocking on Prince Edward Island is restricted to two landlocked ponds.

Rainbow trout are cultured for commercial purposes in all five eastern provinces producing wild Atlantic salmon. Currently they are being cultured in both land-based facilities and marine cages. Escapes occur from both and appear to be increasing in some areas, presumably coincident with the expansion in their culture. Reports this year indicate increased numbers of rainbow trout escapees in estuaries and rivers along Nova Scotia's Atlantic coast and Newfoundland's south and west coasts. The presence of males among escapees caught in Newfoundland waters suggest that the source of at least some of the escapees is outside the Province of Newfoundland.

Rainbow trout appear to be the least tolerant of the salmonids to acidic waters, their lower tolerance limit being pH 5.5-6.0 (Grande et al. 1978). Accordingly, rainbow trout are prevented from reproducing successfully in most rivers along the Atlantic coast of mainland Nova Scotia. Similarly, their limited distribution in Newfoundland rivers may in part be attributed to their acid conditions (Chadwick and Bruce 1981). However, acidic conditions are not limiting in the majority of Canada's salmon producing rivers.

The early life stages of the Atlantic salmon and rainbow trout are remarkably similar in habitat preferences, behavior, and feeding (Bley and Moring 1988). So much so that Gibson (1981) suggested that at the juvenile stages the rainbow trout was likely to significantly interact with Atlantic salmon. Studies conducted by Hearn and Kynard (1986) in experimental stream channels and in field experiments, suggested that rainbow trout are better adapted to pools and habitats with low current velocities and in such habitats are more aggressive and will out-compete Atlantic salmon parr. They concluded that the apparent displacement of Atlantic salmon from pool habitats may have implications for fishery managers contemplating the introduction of rainbow trout to Atlantic salmon streams. They further stated that such interspecific interactions may cause reductions in salmon production. Although Atlantic salmon juveniles are generally riffle dwelling and prefer higher current velocities, pools are important habitat for the older and correspondingly larger parr (Gibson 1981). Standing waters (lakes and ponds) are also commonly used as productive habitat for salmon parr in Newfoundland rivers (Pepper 1976; O'Connell and Dempson 1995, 1996).

Smolts of both species emigrate in the spring (Maher and Larkin 1955). Competition would not be expected at this time since invertebrate food is usually abundant in the spring and early summer, and habitat during emigration down the river and in the estuary would be only temporarily occupied. However, an increased number of smolts may attract more predators. Further, large rainbow trout, which frequently are piscivorous, could inhabit the estuary and other habitats, such as lakes and pools, either

as residents or as migrating steelhead, and if abundant could reduce the number of Atlantic salmon smolts.

Spawning of Atlantic salmon is in the late autumn, whereas rainbow trout spawn in the late winter or early spring (Jones 1959; Smith 1973). However, both species spawn in coarse gravel in shallow fast water at the tail of pools. Considering this common preference for spawning habitat, it seems reasonable to assume that large rainbow trout could over-cut Atlantic salmon redds and cause disturbance of developing salmon alevins. Such negative interaction by rainbow trout on brown trout has been reported by Hayes (1988).

In contrast to research findings, data are lacking to show that rainbow trout have successfully colonized any waters with healthy populations of Atlantic salmon in North America. However, rainbow trout have been successfully introduced around the world in many types of habitat, and in some systems have become the dominant fish species (MacCrimmon 1971).

Conclusions: Although available scientific information is sparse, it does indicate the potential for interspecific competition between the two species with negative consequences to the native Atlantic salmon. In consideration of this and that rainbow trout are escaping from culture facilities in significant and increasing numbers, the Committee agrees that cautionary measures would be prudent.

The Committee concluded that the risks would be minimized without sterilization as specified in the draft protocol, provided all cultured rainbows were rendered mono-sex and they were adequately contained. This latter measure is important because without such improvement the potential for direct interaction between escaped rainbow trout and Atlantic salmon will continue to exist.

The Committee further noted that these measures could only be effective if applied uniformly to all areas. Uniform application was concluded to be necessary considering both the long range migratory behaviour displayed by rainbow trout and that not all culture operations can be made "escape proof". Exceptions to these requirements could be land-based facilities at which risk of escapement were shown to be low.

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Issue: Are the proposed draft NAC Protocols contrary to policy direction advocated by the American Fisheries Society (AFS)?

Position or policy direction advocated by AFS is general in nature as is necessary to encompass a diversified array of species, geograghic areas and circumstances. The underlying principles and rationale seem to be consistent for both AFS and NAC documents. The NAC Protocols are however more detailed and specific because they apply to a single species, the Atlantic salmon.

Conclusion: NAC Protocols are not contrary to position or policy direction advocated by AFS.

Issue: Is the effective number of parents (N_e) of 100 "an objective" or "an absolute requirement" for hatchery rearing programs to support introduction, re-establishment, rehabilitation and enhancement of Atlantic salmon? (Protocol 2.2.1 (j))

An N_e of 100 is not always feasible or desirable when considering the alternative of doing nothing. These exceptions generally exist as a result of the recipient or donor populations being small and/or the desired intervention being small. Each intervention through the use of hatchery rearing and stocking should be carefully designed taking into consideration sound genetic principles.

Conclusion: The Committee agrees with the current wording in 2.2.1 (j) since it confers the protocol statements as "objectives" rather than "absolute requirements".

Issue: Should the wording of the draft protocol statement under 2.2.3.4 Aquaculture, pertaining to "the practice of freshwater cage rearing" be changed to reflect that the practice "be prohibited" rather than "should not be encouraged", as currently stated?

The Committee recognises the higher risks associated with cage rearing in fresh water and estuaries. However, there may be situations or locations in fresh water or estuaries where the harmful effects of cage rearing salmonids would be minimal. The current wording infers that cage rearing in fresh water and estuaries is not generally a desired practice but yet allows for those exceptions. Proposals to undertake cage rearing in either of these areas could be assessed on an individual basis.

Conclusion: The Committee agreed with the current wording in the draft protocol.

Issue: Several of the draft protocols advocate assessment before action is taken thereby assuming that the consequences of alternative actions can be predicted. Some of these pertain to competitive interactions between different species of salmonids. Are there valid models to assess interactions between different species of salmonids? Can the outcomes of such interactions be predicted with accuracy? (Protocol 4.4 c)

The construction of envirograms is one means of identifying the possible interactions that are most likely to occur. Both the life histories and habitat preferences of the various salmonid species are fairly well understood but knowledge of the consequences of direct interactions between species is relatively sparse. This is more so the case for interactions between species whose native ranges do not overlap, like various Pacific salmon species, including the rainbow trout, and the Atlantic salmon.

Conclusion: There are no specific models to assess interactions between species but envirograms are useful in identifying possible interactions. The current level of knowledge generally allows for crude predictions of outcome from specific interactions but clearly further research is required to enhance understanding and prediction accuracy.

Fish health

Issue: Is the precautionary approach applied to fish health concerns in the NAC protocols?

Conclusion: After reviewing the NAC protocols, it is the understanding of the Committee that the precautionary approach is not applied to fish health issues. National, State, provincial, and regional legislations, guidelines, or protocols already in place cover these issues.

Issue: Fish health decisions are not based on a proper risk assessment methodology. (Protocol 2.2.1.c)

The Committee agrees with this comment. Revisions to the Canadian Fish Health Protection Regulations (FHPR) currently in progress will provide additional assurances that fish health issues continue to be properly addressed. Revisions to the FHPR

include several new components that will bring the Canadian regulations in line with international standards. They include:

- FHPR will apply to all finfish not just salmonids
- Compensation for eradication of exotic diseases
- Mandatory reporting of listed diseases
- a Quality Assurance/Quality Control (QA/QC) program
- Introduction of the concept of zoning and surveillance
- a Risk analysis methodology in the Manual of Compliance

Conclusion: The inclusion of a risk analysis process in the revised version of the FHPR addresses this specific concern raised in some submissions.

Issue: The NAC protocol supercedes the current FHPR in force in Canada (Protocol 2.2.1.d).

Conclusions: The Committee believes that fish health issues are adequately covered in the NAC protocol. Fish health recommendations contained in the NAC protocol are largely based on existing international (Office International des Epizooties (OIE), Aquatic Animal Health Code), national (FHPR) and regional regulations and policies. It is also the Committee's interpretation that the NAC protocol does not supercede the existing FHPR.

Risk Analysis

Issue: Several submissions indicate that the NAC protocol has an inadequate description of risk assessment methods and that the level of risk was not assessed using proper risk analysis procedures. (Protocol 2.2.1.c)

The Committee understands that risk analysis is defined as a specific process including three components, risk assessment, risk management and risk communication. The main purpose of this process is to provide a standardised approach to evaluating the risk associated with the introduction or transfer of an aquatic organism. When an introduction and transfer is contemplated the three main categories of risk outcomes that must be considered are genetic, ecological, and disease. The risk assessment process primarily assesses the probability of introducing undesirable biological agents. The major components to be addressed in assessing the magnitude of an impact (consequences) are environmental, perceived (social and political influences), and economic. A methodology for risk analysis is already included in the draft national policy on Introductions and Transfer of Aquatic Organisms and in the revised FHPR.

Advantages of a risk analysis are a) a standardised framework to decision-making that can be applied to all requests for introduction and transfer so that a consistent approach is used, b) a platform where all scientific, technical, and any other relevant information can be summarised into a format which will be understandable and helpful for managers to reach a decision, and c) a process that allows for a clear open and transparent evaluation of risks including input from all interested parties.

Conclusions: In response to these concerns, the Committee strongly supports the use of risk analysis in decision making relative to introductions and transfers of aquatic

organisms. A copy of the risk analysis procedure should be appended in the NAC protocol and appropriate text developed to indicate its application.